CONSENSUS DOCUMENT

Recommendations for the pharmacological treatment of hyperglycemia in type 2 diabetes

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Received 28 June 2010; accepted 16 July 2010

Introduction

Type 2 diabetes is a condition characterized by chronic hyperglycemia secondary to a dual pathogenetic mechanism: resistance to insulin action associated with progressive failure in pancreatic insulin secretion. Insulin resistance usually continues throughout the course of the disease, but may be improved with lifestyle changes (nutritional therapy and exercise), the achievement of more favorable anthropometric characteristics, and some drugs. Progressive failure in pancreatic insulin secretion should lead to early and active action being taken, with a gradual increase in
both the dosage and number of drugs to maintain control objectives.

Some scientific societies\textsuperscript{1-6} have prepared consensus documents with recommendations regarding control objectives, stepped use of the different drugs, and the adaptation of both to the patient’s characteristics. Such documents show both similarities and discrepancies because of the difficulties resulting from the lack of randomized, adequately powered clinical trials directly comparing the different treatment schemes recommended. The Board of the Spanish Society of Diabetes (SED) thus decided to commission our Working Group to prepare a document in which the available evidence and the different recommendations were adapted to the situation in Spain, taking into account that the final therapeutic decision will always depend on the physician, who must consider the specific characteristics of each patient. The Working Group considered that this document should be dynamic and regularly updated to take account of incoming evidence and on suggestions from SED members.

Control objectives

The achievement of good metabolic control may prevent or delay the occurrence of microvascular and macrovascular complications, as has been shown by various studies with long-term follow-up times in patients with both type 1 (DCCT/EDIC)\textsuperscript{7} and type 2 diabetes (United Kingdom Prospective Diabetes Study [UKPDS])\textsuperscript{8}. By contrast, if strict glycemic control is performed in patients with long-standing diabetes, advanced complications, or severe associated diseases, not only is a greater cardiovascular prevention not achieved (Action in Diabetes and Vascular disease: preterAx DiamicroN MR Controlled Evaluation [ADVANCE])\textsuperscript{9} and Veterans Affairs Diabetes Trial [VADT])\textsuperscript{10}, but mortality may even increase (Action to Control Cardiovascular Risk in Diabetes [ACCORD])\textsuperscript{11}. Very strict control is therefore recommended in the early phases of diabetes treatment (glycosylated hemoglobin [HbA\textsubscript{1c}] < 6.5%), provided that the patient is not older than 70 years and has no advanced microvascular or macrovascular complications at the time of diagnosis or any associated diseases that make it advisable to avoid hypoglycemia. In this case, the recommended control HbA\textsubscript{1c} value would be < 7.5% or the best possible that would ensure treatment safety, adapted to the patient’s condition and compatibility with concurrent drugs. It is generally admitted that approximately 10 years after disease onset, monotherapy is usually inadequate, and most patients will require combined treatment, often with insulin. When this occurs, it may be advisable to increase the control goal to HbA\textsubscript{1c} < 7.5% unless the traditional 7% goal is feasible and safe.

It should be borne in mind that hyperglycemia is only one of the cardiovascular risk factors in diabetic patients and that there are other associated risk factors such as dyslipidemia, hypertension, obesity, and smoking. These will greatly condition the potential occurrence of complications and patient survival. Thus, although it is beyond the scope of this document, the monitoring of these risk factors is expressly recommended as it has been shown to be highly effective (STENO-2)\textsuperscript{12}.

Therapeutic inertia

After treatment has been started, or if it has been changed, a number of aspects, such as metabolic control, should be assessed by measuring HbA\textsubscript{1c}, and evaluating capillary blood glucose profiles (when appropriate), tolerability of changes made, and the course of associated complications and diseases.

This must be done approximately every 3 months following the acute phase of treatment adjustment, and at least until the condition stabilizes. Then, when goals have been achieved, all patients must be monitored at least twice every year. If the changes made have not been effective in achieving the control objective in the initial 3 months and such failure has not been due to intercurrent diseases or use of drugs, treatment should be intensified and decision taking should not be delayed. It is extremely important to maintain good metabolic control, particularly in patients with recent onset of the disease, who may be asymptomatic despite failure to achieve the control objectives. The main barriers to treatment intensification may occur when a change in treatment requires an additional diabetological education process, as may occur for instance when secretagogues or insulin are started. These situations should be anticipated so as to avoid unnecessary delay.

It is important to plan medical and nursing action guidelines and drug treatment monitoring by the pharmacist for dose intensification, but it is equally important to plan the changes in treatment required by acute intercurrent conditions that may cause some degree of dehydration or difficult intake (febrile syndrome, vomiting, diarrhea, and so on). These conditions may make the current treatment of the patient unsafe and require its urgent modification\textsuperscript{13}.

Stepwise treatment

A number of drugs are currently available for the treatment of diabetes, including metformin, sulfonylureas, glinides, thiazolidinediones, diacaridase inhibitors, dipeptidyl-peptidase 4 (DPP-4) inhibitors, and glucagon-like peptide-1 (GLP-1) receptor agonists, which, together with insulin, may be used as monotherapy or in combination. These drugs should be used after consideration of their respective prescribing information; some combinations have been shown to be safe, others are not recommended, and for still others long-term safety is unknown. The choice of treatment will depend on its potency to decrease HbA\textsubscript{1c}, the risk of inducing hypoglycemia and the degree of prior control, its influence on body weight and dyslipidemia, its preferential impact on basal or post-prandial blood glucose, any associated complications or diseases of the patient, the risk of drug-related adverse effects, tolerability, and cost (Table 1).

Initial drug treatment will vary depending on the prior degree of control, age, the presence of concurrent diseases, and the concomitant use of other drugs. As shown in the algorithm (Fig. 1), treatment will usually start with a single
## Table 1  Main characteristics of oral antidiabetic drugs

<table>
<thead>
<tr>
<th>Drug Class</th>
<th>Risk of hypoglycemia</th>
<th>Advantages</th>
<th>Disadvantages</th>
<th>Contraindications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metformin</td>
<td>No</td>
<td>• No weight increase</td>
<td>• GI adverse effects (titrate dose)</td>
<td>• GFR &lt;60 mL/min</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Improves lipid profile and other cardiovascular risk markers</td>
<td>• Lactic acidosis (very rare)</td>
<td>• Severe heart failure</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Decreased mortality and microvascular complications in obese patients</td>
<td>• Interferes with vitamin B12 absorption</td>
<td>• Liver insufficiency</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(UKPDS)</td>
<td></td>
<td>• Respiratory insufficiency</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Improves lipid profile (titrate dose)</td>
<td></td>
<td>• Alcoholism</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Decreases CVD risk markers</td>
<td></td>
<td>• Use of iodinated contrasts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Decreases CVD and risk markers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sulfonylureas</td>
<td>Glibenclamide (significant)</td>
<td>• Decreased microvascular complications (UKPDS/ADVANCE)</td>
<td>• Weight increase</td>
<td>• Severe renal failure (GFR &lt; 30 mL/min)</td>
</tr>
<tr>
<td></td>
<td>Gliclazide (moderate/minimum)</td>
<td></td>
<td>• Shortened duration of hypoglycemic efficacy as compared to metformin and glitazones</td>
<td>• Severe liver insufficiency</td>
</tr>
<tr>
<td></td>
<td>Glimepiride (moderate)</td>
<td></td>
<td></td>
<td>• Allergy to sulfonamides</td>
</tr>
<tr>
<td>Glinides</td>
<td>Repaglinide (moderate)</td>
<td>• Not contraindicated in mild to moderate renal failure</td>
<td>• Weight increase</td>
<td>• Severe liver insufficiency</td>
</tr>
<tr>
<td></td>
<td>Nateglinide (minimum)</td>
<td>• Reduce post-prandial blood glucose</td>
<td>• Do not combine repaglinide with gemfibrozil</td>
<td></td>
</tr>
<tr>
<td>Thiazolidinediones</td>
<td>No</td>
<td>• Not contraindicated in moderate renal failure</td>
<td>• Weight increase</td>
<td>• Heart failure</td>
</tr>
<tr>
<td>or glitazones</td>
<td></td>
<td>• Pioglitazone improves lipid profile and other cardiovascular risk markers</td>
<td>• Edema</td>
<td>• Liver insufficiency</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Longer glycemic control (as compared to metformin or sulfonylureas)</td>
<td>• Increased incidence of heart failure</td>
<td>• Rosiglitazone:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Longer glycemic control</td>
<td>• Increase limb fractures in females</td>
<td>• Ischemic heart disease</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(as compared to metformin or sulfonylureas)</td>
<td>• 6-12 weeks are required for maximum effect</td>
<td>• Peripheral vascular disease</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Not contraindicated in cardiac complications</td>
<td></td>
<td>• Combined with insulin</td>
</tr>
<tr>
<td>Alpha-glycosidase</td>
<td>No</td>
<td>• No weight increase</td>
<td>• Weight increase</td>
<td></td>
</tr>
<tr>
<td>inhibitors</td>
<td></td>
<td>• Reduce post-prandial blood glucose</td>
<td>• Low efficacy if diet poor in CHs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Decrease mortality and cardiovascular complications</td>
<td>• Decreased mortality and cardiovascular complications</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Hypoglycemia should be treated with pure glucose</td>
<td>• Hypoglycemia should be treated with pure glucose</td>
<td></td>
</tr>
<tr>
<td>DPP-4 inhibitors</td>
<td>No</td>
<td>• No weight increase</td>
<td>• MIglitol</td>
<td>• Miglitol</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Mainly reduce post-prandial blood glucose</td>
<td>• GFR &lt; 60 mL/min</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Acute pancreatitis has been reported</td>
<td>• Acarbose</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Unknown long-term benefits and safety</td>
<td>• GFR &lt; 30 mL/min</td>
<td></td>
</tr>
<tr>
<td>GLP-1 agonists</td>
<td>No</td>
<td>• Weight decrease</td>
<td>• Vildaglaptin:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• BP decrease</td>
<td>• Liver insufficiency or ALT or AST &gt; 3 x UNL</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Lipid improvement</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Mainly reduce post-prandial blood glucose</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Subcutaneous administration</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• GI adverse effects (nausea, vomiting, diarrhea)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Acute pancreatitis has been reported</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Unknown long-term benefits and safety</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Not indicated with insulin, as monotherapy, or in triple therapy</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CHs, carbohydrates; GFR, glomerular filtration rate; GI, gastrointestinal.
drug, and two-drug treatment will be considered as a second step. Insulin or triple therapy may finally be required if the degree of control in the patient makes it advisable.

First step

Patients with HbA1c values ranging from 6.5% to 8.5%

The control goal (HbA1c < 6.5%) may be achieved in some patients with some lifestyle changes14, but this approach is not always effective because it depends on the patient’s characteristics and how well the patient follows the recommendations made. The SED thus recommends concomitant administration of metformin from the start in most patients15-16. In any case, the introduction of metformin should not be delayed for longer than 3 months if the control goal has not been achieved. To improve metformin tolerability, gradual dose titration is advised17. For example, half an 850-1,000 mg tablet may initially be given, which is increased to half a tablet every 12 h at 4-5 days if tolerability is good, and so on until a dose of 850-1,000 mg every 12 h is reached. If intolerance occurs, the drug should be reduced to the prior dose tolerated and dose increase should be attempted again with a longer time interval.

Alternatives to treatment with metformin if this is contraindicated or not tolerated include:

- **First alternative: sulfonylureas.** With a control goal of HbA1c < 6.5%, as potent secretagogues they involve a significant risk of hypoglycemia, but the risk is different depending on the active ingredient used18-20. A very careful dose titration and the preferential use of sustained release gliclazide or glimepiride should be considered. The use of glibenclamide or chlorpropamide is not recommended. Some studies suggest that sulfonylureas induce secondary beta cell failure sooner than metformin or glitazones21. They are also associated with a 1-3 kg weight increase22,23. Some guidelines do not recommend them in this treatment step.

- **Second alternative: DPP-4 (dipeptidylpeptidase-4) inhibitors.** These have clear advantages for use in this treatment step as an alternative to metformin if this is not tolerated. They involve a minimum risk of hypoglycemia when given as monotherapy and have no impact on patient weight24,25. Today, the main limitations on their use are the lack of studies showing their long-term efficacy and safety, and their high price. To date, only sitagliptin26 has been approved for this indication, although other active ingredients of the same class are pending authorization27,28.

- **Third alternative: glinides.** The option in this step is repaglinide29. Nateglinide should be used in combination because of its pharmacodynamic characteristics and potency30. In principle, it has the same limitations as sulfonylureas, but because of its characteristics and form of administration it may be suitable for patients with irregularities in diet and physical activity31,32.

- **Fourth alternative: thiazolidinediones or glitazones.** These require 10 to 12 weeks for maximum efficacy, and have a potency in terms of HbA1c reduction similar to
metformin and sulfonylureas. Their potential side effects include weight increase, edema, anemia, fractures, and heart failure in some patient groups\textsuperscript{33-35}, which have limited their indication. In addition, it has not been clearly elucidated whether differences exist between rosiglitazone and pioglitazone, as has been suggested by some observational studies\textsuperscript{36}, and the question thus remains open until studies directly comparing both molecules are completed. These drugs may have a more relevant role in patients with severe metabolic syndrome\textsuperscript{37} and/or non-alcoholic steatohepatitis\textsuperscript{38}.

- **Fifth alternative: disaccharidase inhibitors**. These are less potent than the drugs mentioned above and are not associated with hypoglycemia when given as monotherapy. Their greatest limitation is intestinal intolerance, which requires treatment discontinuation in a high proportion of patients\textsuperscript{39}. Their greatest benefit is that they appear to significantly improve cardiovascular risk (STOP-NIDDM)\textsuperscript{40}. Two preparations have been marketed, acarbose and miglitol.

- **Sixth alternative: basal insulin**. In this step, insulin is reserved for patients in whom oral drugs are contraindicated.

**Initial treatment for patients with HbA\textsubscript{1c} > 8.5%**

In patients with significant clinical signs of hyperglycemia (cardinal clinical signs and/or weight loss) at disease onset, treatment with insulin\textsuperscript{41-43}, alone or combined with metformin, is usually required. After initial control and improvements in glucotoxicity and lipotoxicity, insulin requirements are likely to gradually decrease, and control may be maintained in some cases with oral drugs, either as monotherapy or in combination.

In asymptomatic patients, it is advisable to start with metformin using a faster titration and, depending on response, to add a second drug\textsuperscript{44}, with monitoring of its course in the short term in order to adjust final treatment.

**Second step**

In patients in whom control goals have not been achieved or who, after a period of adequate control, experience impairment due to the course of their diabetes (in the absence of any associated disease or drug increasing glycemia), a second drug should be added.

Long-term comparative studies are lacking for most drug combinations, which makes taking decisions difficult. In principle, it is recommended that associated drugs have different and complementary action mechanisms. Based on the response, dosage should be increased to the maximum effective dose, somewhat lower than the maximum dose allowed. It should also be borne in mind that the contraindications, limitations for use, and potential side effects are the same as those of both drugs separately.

**Combinations with metformin**

- **Sulfonylureas and glinides**. Metformin-sulfonylurea combinations are the most widely tested and have been shown to be effective and safe\textsuperscript{42-45}, although doubt still exists about the increased mortality in a subgroup of patients seen in the UKPDS\textsuperscript{46} who started treatment with sulfonylureas and had metformin added in a second step. Various observational studies have addressed this issue\textsuperscript{47-51} and reported somewhat conflicting results, which moreover may not be superimposable on those obtained with more recent preparations. The risks for the control goal (HbA\textsubscript{1c} < 6.5%) are similar to those seen in monotherapy, and the same recommendations are therefore made. Glinides represents a viable alternative to sulfonylureas for patients with more irregular intake because of their short action period, and also for patients allergic to sulfonylurides or, in the case of repaglinide, for patients with moderate renal failure\textsuperscript{52}. As regards the risk of hypoglycemia and weight increase, they may be considered as superimposable, with a potency lower than nateglinide\textsuperscript{53} and quite similar to repaglinide\textsuperscript{54}.

- **DPP-4 inhibitors**. These drugs, together with GLP-1 receptor agonists, form a novel group of secretagogues acting on both insulin and glucagon secretion. They have obvious advantages over sulfonylureas and glinides, including a low risk of hypoglycemia and weight neutrality\textsuperscript{55} and\textsuperscript{56}. However, their long-term safety and their impact on the course of diabetes and its complications are unknown. Their potency does not appear to be lower than that of sulfonylureas in terms of HbA\textsubscript{1c} reduction\textsuperscript{57,58}. They could be a preferential option in patients in whom hypoglycemia is unacceptable.

- **GLP-1 receptor agonists**. These are parenteral preparations achieving a stronger and longer effect on GLP-1 receptors than DPP-4 inhibitors. In the short-term studies published, they have been shown to improve glycemic control, especially post-prandial blood glucose, and partly also basal blood glucose\textsuperscript{59}. They slow gastric emptying, creating a sensation of satiety, which results in a sustained weight reduction in a substantial proportion of patients\textsuperscript{60,61}. They also achieve improvements in some vascular risk factors\textsuperscript{62}. In Spain, exenatide has been marketed for parenteral administration twice daily (before main meals, with an interval of at least 6 h between them) associated with metformin and/or sulfonylureas and with metformin plus glitazone\textsuperscript{63}, in patients with a body mass index greater than 30 kg/m\textsuperscript{2}. The marketing of liraglutide is pending at the time of writing these guidelines\textsuperscript{64}. We therefore recommend reading its prescribing information to assess its indications and limitations for use. This may be a highly useful drug class in patients in whom obesity is an essential problem, but its role as compared to other drugs or treatment approaches, such as surgery, has still to be defined.

- **Thiazolidinediones**. These drugs act by increasing insulin sensitivity by a different mechanism as compared to metformin, and are therefore frequently used in combination\textsuperscript{65-68}. In principle, they should mainly be indicated for patients with good post-prandial glucose control and elevated basal blood glucose not totally corrected with metformin. Their side effects are similar to those of each drug alone, and the same limitations as in monotherapy therefore apply.

- **Basal insulin**. The combination of basal insulin with metformin is a good therapeutic option of proven safety and efficacy\textsuperscript{69-71}. It is mainly indicated for patients with
good post-prandial control but with HbA1c above the recommended objective. Although this approach increases the rate of hyperglycemia, this is still much lower than that found in patients with multiple insulin doses. It is a good alternative for patients with in whom treatment with glitazones is not appropriate.

- **Disaccharidase inhibitors.** Their combination with metformin is safe, as no hypoglycemia will occur, but they have a limited efficacy, with HbA1c decreases hardly exceeding 0.5%79. Their main limitation is gastrointestinal intolerance. They are therefore not recommended as an alternative to a second drug in this therapeutic step.

### Third step

In patients treated with two drugs with poor metabolic control, the next step is insulin therapy. Except in patients resistant to insulin therapy, there are no «advantages» in delaying insulin introduction in the treatment regimen after dual combined therapy has failed. The long-term benefit and safety of an oral triple therapy as compared to insulin use is uncertain because follow-up in the different clinical trials is not longer than 12 months.

### Combinations including no insulin

Among the different and valid combinations of oral agents, the combination of metformin, sulfonylurea, and glitazone is the most widely tested and most commonly used in clinical practice. It would thus be the one recommended in most patients with type 2 diabetes and poor control with dual therapy73-77. In elderly patients78, the combination of metformin, repaglinide, and glitazone may be safer. In patients with limitations on the use of glitazones, the most reasonable alternatives would be metformin plus sulfonylureas plus DPP-4i79 or metformin plus repaglinide plus DPP4i80, although these have the disadvantage that they have been less widely tested.

### Combinations including insulin

Most patients will have been treated with combinations of metformin and secretagogues. To these, basal insulin is added. If time since diabetes onset is longer than 10 years and/or complications or intercurrent diseases have occurred, the control goal will be revised to less than 7.5% or the best possible that is considered safe for the patient. This scheme may achieve a period of good control, but not an excessively long one, to judge from the results of the 4T study (Treating-To-Target in Type 2 diabetes)81. Hence, most patients will require an intensified insulin regimen within approximately 3 years. If this occurs, it is advisable to continue treatment with metformin combined with insulin, and to discontinue all other oral antidiabetic treatment.

### Fourth step

As regards the possibility of quadruple therapy, which is a feasible approach (due to the different pathophysiological pathways from the pharmacological viewpoint), we think that this is currently an investigational approach, rather than a possibility in clinical practice.

### Conclusions

Once lifestyle changes have been implemented, the goal of drug treatment for type 2 diabetes will be to achieve an optimized degree of metabolic control with the maximum possible safety. The goal should be an HbA1c value < 6.5% in the early stages of disease and < 7.5% in more advanced stages or when there is a risk of hypoglycemia.

Treatment is divided into 3 steps. In the first step, and if hyperglycemia is not too high (HbA1c, 6.5%-8.5%), metformin is the drug of choice. Other alternative drugs will only be used if metformin is not tolerated or is contraindicated. If hyperglycemia is high (HbA1c > 8.5%), initial treatment should consist of several oral drugs combined, or insulin therapy should be started. The second step consists of the addition of a second drug with a synergistic action. Various options are available for this, and should be individualized, based on the characteristics of each patient. Finally, the third step implies the introduction of basal insulin as a preferred option to oral triple therapy, which must be reserved for insulin-resistant patients only.

### Conflict of interest

The authors state that they have no conflict of interest.

### Annex A.

*Study promoted by the Spanish Society of Diabetes (SED) in collaboration with:*

- Spanish Society of Atherosclerosis (SEA).
- Spanish Society of Cardiology (SEC).
- Spanish Society of Endocrinology and Nutrition (SEEN).
- Spanish Society of Community Pharmacy (SEFAC).
- Spanish Society of Family and Community Medicine (SEMFYC).
- Spanish Society of Internal Medicine (SEMI).
- Spanish Society of Primary Care Physicians (SEMERGEN).
- Spanish Society of General and Family Physicians (SEMG).
- Spanish Society of Nephrology (SEN).

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Addendum to the Consensus Document «Recommendations for pharmacological treatment of hyperglycemia in type 2 diabetes»

As of September 23, 2010 the EMA decided to withdraw from the market all medicinal products containing rosiglitazone as an active ingredient (Avandia®, Avandamet® and Avaglim®) because the benefits of the drug were not considered to outweigh its potential risks. In this context, the FDA decided not to withdraw such products from the market, but proposed a number of pharmacovigilance measures. The FDA thinks that data suggesting a potential increase in cardiovascular risk associated with rosiglitazone are controversial and not definitive. Independent verification of the results of the RECORD study has been requested.

References


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